

COUPP Camera Trigger Interface Controller Module Requirements

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1 Introduction

This document describes the functional and mechanical requirements for the COUPP Camera Trigger Interface Controller (CTIC). The CTIC is a relatively unintelligent module whose primary function is to provide trigger connectivity between the cameras, the system host PC, the piezo controller, and the system PLC. The CTIC also provides logic level conversion, power to the cameras, distributes synchronization gate signals to the cameras, and drives the flash LED arrays. Triggers generated by any of the trigger sources are passed to the trigger destinations. Trigger sources include the cameras, the host PC, the piezo controller, and the front panel External Trigger Input. Trigger destinations include the cameras, the host PC, the PLC, and the front panel External Trigger Output.

2 Requirements

This section describes CTIC requirements that are necessary to achieve the goals of the COUPP experiment. The CTIC provides a cabled connection to each camera, the camera flash LED arrays, the PLC, the piezo controller, and to the system host machine's I/O card to allow programmed control and monitoring of the cameras.

2.1 *Power Requirements*

The CTIC will be powered by 110VAC 60Hz line cord to a North American standard NEMA 5-15 outlet. A power switch will be provided in a convenient location on front panel of the enclosure. The AC to DC power supply must be internal to the CTIC enclosure, and must ensure 85% or greater power conversion efficiency.

2.2 *Cooling*

The CTIC will be air cooled. Cooling air may be drawn from the front or bottom of the enclosure. Air may exit the enclosure through the top or rear of the enclosure. The CTIC mechanical design must ensure that all component temperatures do not exceed the manufacturers' recommendations under all expected operating conditions. Fans may be used but should be avoided if possible. If used, fans must be rated for at least 200,000 hours MTBF or 70,000 hours L10, and at least one more fan than is actually needed should be installed for redundancy. Any fans used must be equipped with a tachometer sensor. At least one internal temperature sensor with accuracy of +/- 1 degree C or better must be implemented in the CTIC. The sensor must be placed as near the greatest heat source in the module as is practical. All sensors must be readable through the Host PC USB interface.

2.3 *Packaging Requirements*

The CTIC will be contained in a 19" standard rack-mounted enclosure no greater than 2U in height, and no larger than 25cm deep. A metal shielding enclosure is preferred. The maximum size of any unshielded opening in the enclosure is to be no larger than 6mm square, with no limit to the number of openings.

2.4 Connectivity Requirements

2.4.1 Camera Connection Requirements

The CTIC will provide cable connections to eight Basler exA640-180m cameras. The cables will each terminate in 12-pin Hirose HR10A-10P-12S micro-miniature locking plug (or the equivalent). The pinout of this connector will conform to that specified in the Basler Excite Operating Manual (Basler Document Number: DA000745). The CTIC will provide logic level conversion as necessary.

2.4.2 Host Computer Connection Requirements

The CTIC will provide a cable connection to a National Instruments PXI-6221 Data Acquisition I/O card in a Host PC. The connector and pinout for this connection will conform to that specified in the National Instruments PXI-6221 Data Acquisition I/O card manual (NI 622x Specification). The CTIC will provide logic level conversion as necessary. The CTIC will also provide for a USB connection to the host computer. The USB interface IC used on the CTIC must be supported natively by Scientific Linux Fermi version 5.0 and above.

The state of important device status data will be latched upon receipt of any trigger condition. This data is to be readable via memory mapped registers through the Host PC USB port.

2.4.3 Piezo Electronics Connection Requirements

The CTIC will provide a cable connection to the Piezo Controller. The connector and pinout for this connection will conform to the Piezo Controller Operators Manual (Document Number: xxxxx). The CTIC will provide logic level conversion as necessary.

2.4.4 Camera Flash LED Array Connection Requirements

The CTIC will provide a cable connection to each of the Camera Flash LED Arrays. The connector and pinout for this connection will conform to the xxxx document xxxxx. The CTIC will provide appropriate driver circuitry.

2.4.5 PLC Connection Requirements

The CTIC will provide a cable connection to the COUPP system PLC. The connector and pinout for this connection will conform..... The CTIC will provide logic level conversion as necessary.

2.4.6 External Trigger I/O

The CTIC will provide an external trigger input and an external trigger output on a front panel mounted LEMO type connector. Logic levels of these connections will conform to the NIM specification.

2.5 Functionality

2.5.1 Internal Logic

The CTIC will provide logical connection of the system components using a reprogrammable CPLD or similar device. The device will be non-volatile and retain its configuration through power cycling. The device will be reprogrammable through the Host PC USB connection.

2.5.2 Shutter Gate Signal Requirements

The CTIC will provide a shutter gate signal to each camera at the appropriate logic level. Cameras will synchronize to this gate signal and acquire an image when the gate is true. Cameras may not acquire an image or fire their flash units when the supplied gate is false. Gate signals will enable the cameras in a round-robin fashion at a selectable rate. The frame rate can be configured via the Host PC USB Interface to 180, 160, 140, 120, 100, 80, 60, 40, or 20 frames per second. This arrangement prevents more than one camera from acquiring or firing their flash units at the same time. Individual camera ports can be enabled or disabled via the USB Host PC connection.

2.5.3 Power Requirements

The CTIC will provide 12VDC current limited to 1.8A to each camera. Power supplies to the cameras must be individually controllable, such that they can be enabled or disabled via the Host PC USB interface.

Internal DC to DC power converters must ensure 80% or greater power conversion efficiency.

2.5.4 Camera I/O Requirements

The CTIC will ensure that all camera outputs are loaded such that a minimum of 7 mA of current is drawn at all times and that a maximum of 500 mA is not exceeded. All output ports will be terminated with 470 – 2.2K ohm resistor to ground as specified in the Basler eXcite User's Manual (Basler Document Number: DA00074504).

2.5.5 Camera RS-232 Port Connection

The CTIC will allow connection to the RS-232 port of each camera via the Host PC USB interface.

2.6 Displays

The CTIC will provide LEDs to indicate activity on the various ports. The LEDs will be driven by logic that stretches any pulse (true or false) driving it to a length long enough to allow human perception of the pulse. The CTIC will have an LED indicating that the unit is turned on. Red LEDs are reserved for error conditions.

3 Test Features

3.1 Self-test

The CTIC must include built-in test structures such that internal functions of the module may be tested with minimal use of external test equipment.

3.2 Error Detection

Detectable errors will be displayed via indicators on the front panel, and will be readable through the Host PC USB interface.

3.3 System Diagnostic Port

All external signals connecting to the CTIC will be buffered and available on a .100 x .100 inch pitch two row connector on the front panel.

4 Reliability

4.1 Burn-in

The CTIC hardware must undergo a burn-in process to minimize infant mortality failures in the production system.

4.2 Low-stress Design

Circuit design and implementation practices must be employed to minimize component stress that would adversely affect reliability.

4.3 Fault Tolerance

All input and output connections must be short circuit tolerant. All CPLD I/O connections to external system devices will be buffered.

5 Maintainability

5.1 Maintenance

The CTIC module must be maintainable by module replacement.

5.2 Modularity

The cost, size and complexity of individual circuit boards must be minimized, such that replacement of a board can be considered a viable repair option.

5.3 Programming

All programmable components must be "in-circuit" reprogrammable. The programming interface must be accessible without removing the component from the system.

6 Safety

6.1 Electrical Safety

For 110 VAC power, the safety requirements for high voltage power distribution systems must be followed. For low-voltage (less than 50 volts), high-current (greater than 10 amps) power supplies, the safety requirements for high current power distribution systems must be followed. These are detailed in the Fermilab ES&H Manual, Occupational Safety And Health section on Electrical Safety which can be accessed at:

www-esh.fnal.gov/FESHM/5000/5046.html

A hazard analysis sheet must be completed and signed by any person who will be working with any high-voltage, or low-voltage, high-current system, circuit board, or other electronic device. The internal wiring of a commercially manufactured piece of equipment is exempt as detailed in the FESHM section reference above. The reference provides guidance on load connections, ribbon cables, multiple conductors and mechanical components.

6.2 Dependence

Safety of people or equipment cannot rely on the CTIC module.